Summer 2004

Sex Ratios in Bluebirds Based on Food Availability

Erica Lundberg

Sex Ratios in Bluebirds (*Sialia sialis)* Based on Food Availability

By Erica Lundberg '06 and Advised by E. Raymond Heithaus; Department of Biology, Kenyon College

Figure 1: A typical bluebird nest.

Figure 2: Bluebird chick at age 14 days.

Abstract

Sialia sialis at the Brown Family Environmental Center at Kenyon College produced more males than females during the breeding season of 2003. Evolutionary theory predicts such shifts under conditions of high resource availability, and 2003 had high levels of rainfall (which may indicate more insects as food). For 2004, bluebird breeding was monitored, as well as feeding rates. Random breeding pairs were given access to an added food supply (mealworms).

The bluebird season of 2004 had above average amounts of precipitation, but produced no significant sex ratios among hatchlings. Overall, there were essentially even numbers of male and females bluebirds born in 2004, with 27 males and 25 females. The enrichment of some bluebird boxes also had no effect on the weight of the broods and tarsus lengths of the broods though a slight effect was detected on wing length (GLM, p=0.039, R-sq = 92.83%, F= 4.78). A high amount of blowfly infestation within bluebird boxes had a detrimental effect on the bluebirds, decreasing size of the hatchlings and survival rates.

The feeding rates from 2004 were 60% lower than those of 2003 (GLM, F=6.87, p=0.012). The average rate per hour of 2004 was approximately 7.23 trips compared to 12.06 feeding trips in 2003. Thus the one to one ratio of male to female hatchlings is consistent with the lower feeding rates in 2004 and suggests that there was less nutrient availability in 2004 for the bluebirds and their young.

Questions

- Are sex ratios even in bluebirds?
- Is one sex favored by higher nutrient availability in bluebirds?
- Does high nutrient availability influence the size (weight, tarsus length, wing length) of hatchlings?

Introduction

During times of high productivity, female birds have been shown to produce more males than females (Arnold 2003). In the past, the eastern bluebird, *Sialia sialis* has exhibited similar behavior. The reasoning is that during times of low nutrient availability, female chicks are selected for because they are somewhat smaller and thus easier to produce, and during strenuous times, they are more reproductively successful than males. During conditions of high productivity, male chicks are selected for because they are more reproductively successful due to their ability to father many broods in one mating season (Badyaev 2002).

Last summer, Julie Kordonowy (2003) studied the sex ratios of *S. sialis* chicks. The summer of 2003 had very high levels of rainfall, presumably causing a nutrient enrich environment for the bluebirds. She found that on average, 2.82 male chicks were born per nest in comparison to 1.27 females. Her research produced results supporting the hypothesis that more male hatchlings would be born during times of high productivity. It is expected that under favorable conditions, there will be selectivity towards male chicks of *S. sialis.*

Figure 3: A typical bluebird nest box located to an adjacent corn field at the Brown Family Environmental Center. The male bluebird is feeding the young through the opening in the box while the female waits atop the box with food in her mouth.

Materials and Methods

The bluebirds were carefully monitored throughout the summer. Everyday, the nest boxes were checked for blowflies, eggs and/or hatchlings were counted, and the age of the hatchlings was recorded. Half of the nest boxes containing bluebirds were randomly selected to receive mealworms and the other half (control) received none. We used an open-tray platform to provide the extra food which consisted of 20 mealworms a day. The nests that received the mealworms simulated a fruitful environment and were expected to produce the sex ratio in favor of the males.

Adult bluebirds were captured, weighed, measured, and banded. Once their chicks hatched, the day was recorded, and they were monitored closely. On their 14th day after hatching, chicks were also captured, weighed, measured, and banded. Sex was also determined as soon as prominent plumage was visible. Counting the number of males and females in each brood determined sex allocation.

The feeding habits of parent bluebirds of each nest box were closely monitored to show feeding favorability within a brood and how it correlates to the male- female sex ratios. Each nest was observed for rates of food delivery for at least an hour on day 6 or 7 of hatching and day 12 or 14. Observations were also noted of whether the male or female adult bluebird made the feeding trip to the nest box.

A General Linear Model (Minitab) was used with individual offspring nested within brood to reduce potential confounding effects of nest box location and parental differences. In the nested GLM, main effects were enrichment and sex of the bluebird and dependent variables were nestling weight, wing length or tarsus length among broods.

Figure 4: Bluebird hatchlings at age 4 days

Figure 5: A male bluebird. Males have much brighter coloring in their wings and browner bellies than the females.

Results

Overall this season, similar numbers of male and female hatchlings were born, with 27 males and 25 females. The rest of the analysis did not include the measurements of three hatchlings that died from a blowfly infestation before fledging. In terms of weight (g), tarsus length (cm), and wing length (cm) differences among male and female hatchlings, no significant difference in size was found among male and female hatchlings (GLM, p= 0.127, 0.918, and 0.140 respectively, F= 2.45, 0.01, and 2.30). There was a difference in hatchling weight, tarsus length, and wing length among different broods (GLM, p=0.000, F = 15.85, R-sq = 88.45%).

The enrichment of nest boxes had no positive effect on the weight of individuals within broods (GLM, p=0.915, F= 0.01) or on the tarsus length of the nestlings (GLM, p=0.520, F= 0.43). However, enrichment increased the wing length of the broods (GLM, p=0.039, F= 4.78). Males and females among broods had similar weight (GLM, p=0.551, F= 0.91), tarsus length (GLM, p=0.945, F = 0.41) and wing length (GLM, p=0.462, F = 1.02).

Among the enriched nest boxes, there was an average of approximately 7 total feeding trips per hour made to the boxes by the adults when the chicks were 6 days old. The control nest boxes had an average of 8 feeding trips per hour made to the boxes by the adults. During the summer of 2003, there was an average of 12.06 total feeding trips made to a nest box per hour (Kordonowy 2003). The summer of 2004 had an average of 7.23 total feeding trips made to a nest box per hour. The feeding rates for 2003 are significantly higher than 2004, showing a 60% decrease in feeding trips in 2004 (GLM, F=6.87, p=0.012).

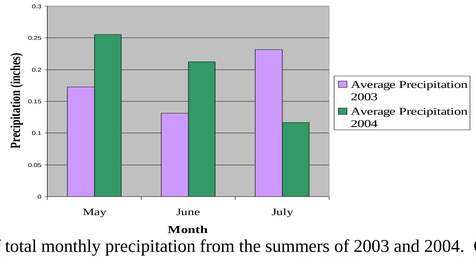

Figure 6: A comparison of total monthly precipitation from the summers of 2003 and 2004. Overall, there was more precipitation through September this year compared to the last. In 2003, the total precipitation was 35.58 inches compared to 2004 that was 39.28 inches. The normal average amount of precipitation for the Wooster area is 30.94 inches (OARDC).

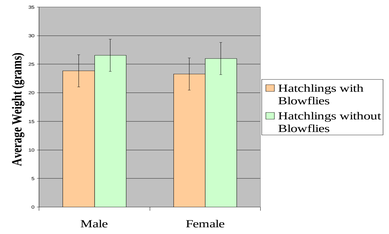

Figure 7: Half of the second brood of the season of bluebirds was widely infested with blowflies. Blowflies negatively affected the weights of the hatchlings (ANOVA, p=0.001, F= 11.34, SE = ± 2.804) with an average weight of female hatchlings with blowflies of 23.27g compared to those without blowflies of 26.06g. The males were affected similarly with an average weight of those affected with blowflies of 23.84g compared to those without blowflies of 26.56g.

Discussion

The lack of any apparent shift in sex ratio in 2004 could be attributed to many factors. The high infestation of blowflies created an uncontrollable factor in the experiment that caused low birth weights and mortality among birds. There were also fewer fledglings this season as compared to last, creating a smaller sample size.

The absence of sex ratios in the summer of 2004 coincides with the fact that the hatchlings of 2004 were fed less frequently than those of 2003. Thus, agreeing with the hypothesis, since there was a 60% decrease in feeding from last year, an even number of male and female hatchlings were born in 2004. The summer of 2004 may have been a more environmentally stressful summer than 2003.

Despite the increase in precipitation this year, the sex ratio does not coincide with the predictions. It was expected that the high levels of rainfall would result in the "under-representation of the morphologies that were selected against and over-representation of morphologies that were favoured"(Badyaev et al., 2002) suggesting that the males would be larger in most aspects—tarsus length, weight, wing length… etc. The month of July was much drier in the summer of 2004 than in 2003, which may have been responsible for the lack of any sex ratios and difference in size between males and females in the second brood. Perhaps precipitation is not the most important factor that influences food availability for *S. sialis.*

The enrichment experiment factor also produced unexpected results. The hatchlings of enriched nest boxes were not fed more than hatchlings of control boxes. It was observed that when extra mealworms were set out on feeding trays at the enriched boxes, those mealworms were not necessarily used for extra food for the hatchlings. Instead, the parents of those hatchlings often used those mealworms to feed themselves before making feeding trips to the boxes. Thus though there was more food set out, feeding trips to the nest box often remained similar to the number of feeding trips made to nest boxes without enrichment.

Future Experiments

We hope that in the future this experiment will have many more repetitions to gain more information about bluebirds in the Mount Vernon, OH area. To improve on this experiment, more nest boxes should be set out on the bluebird trail at the Brown Family Environmental Center in the hopes of having larger sample sizes of broods in the future.

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Bibliography

Arnold, Kathryn E., Griffiths, Richard Stevens, David J., Orr, Kate J.; Adam, Aileen, Houston, David C. November 2003. Subtle manipulation of egg sex ratio in Proceedings of the Royal Society Biological Sciences Series. B 270(Supplement 2) S216-S219

Badyaev, A.V., Hill, G.E., Wittingham, L.A. 2002. Population consequences of maternal effects: sex-bias in egg-laying order facilitates divergence in sexual dimorphism between bird populations. Journal of Evolutionary Biology. 15: (6) 997-1003.

Devine, Julie. 2003. Habitat Differences and Reproductive Success in the Eastern Bluebird (*Sialia sialis*) . Kenyon College Summer Science.

Kordonowy, Lauren. 2003. Intrinsic Male Biased Sex Ratios in Eastern Bluebirds (*Sialia sialis*). Kenyon College Summer Science.

Ohio Research Agricultural and Development Center. OARDC Weather System: Wooster. http://www.oardc.ohio-state.edu/centernet/stations/wohome.asp (October 1, 2004).